

## NOTES ON THE FOODPLANTS OF INDIAN HAWKMOTHS

BY

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The Rev. Miles Moss, in a paper on the Hawkmoths of South America, remarked that he found a very close connection there between Hawkmoths and the plants on which their caterpillars fed, so much so, that having found the caterpillars of a certain species feeding on a certain plant, he confidently expected to find caterpillars of closely allied species feeding on the same, or on closely allied plants.

It may be of interest to examine the foodplants of Indian Hawkmoths to see if there is evidence of a similar close connection in India.

There are one hundred and eighty-one species of Hawkmoths (family *Sphingidae*) known to occur in the limits of the Indian Empire, including Burma, and Ceylon. Information regarding the foodplants of these 181 species which has been published up to now is very scanty, and if we were dependent on the published information no conclusions could possibly be drawn, but my friend T. R. Bell, late of the Forest Department and myself have now bred and kept a record of the foodplants of nearly one hundred species. The foodplants of twenty-two more Indian species, which extend to South China, have been recorded by Rudolph Mell in his *Biologie und Systematik der Südchinesischen Sphingiden* (1922), and it is fairly safe to assume that these twenty-two species feed on the same, or on closely allied plants in both areas. Information collected from other sources brings the total number of species of which one or more of the foodplants are known, up to one hundred and twenty-four, those of the remaining fifty-seven species being unknown. This gives us enough data to examine the question.

The foodplants of the one hundred and twenty-four species cover a very wide range botanically, as they belong to no less than fifty-eight Orders of plants, extending from the Order *Dilleniaceae* (ii) to *Gramineae* (clxxiii), that is, a range of one hundred and seventy-two Orders comprising many thousands of species. In order to show the relationship between the genera of Hawkmoths *inter se*, the number of each Indian genus, in the order in which they appear in *A Revision of the Lepidopterous Family SPHINGIDAE, NOVIATES ZOOLOGICAE*, Vol. ix, *Supplement* (1903) by Rothschild and Jordan, has been entered against each, and the number of each Order of plants, as given in Hooker's *Flora of British India* has been entered against each Order, to show the relationship *inter se* of the plants. These numbers will indicate at a glance the closeness or otherwise of the relationship between the different genera of Hawkmoths and of the different Orders of plants.

Caterpillars of the genus *Clanis* (14) appear to feed exclusively on plants of the Order *Leguminosae* (l). Four out of the five species of this genus which occur in India have been found to feed on plants of this Order. Here, as in South America, we may confidently expect to find the fifth species feeding on a leguminous plant. Caterpillars of the three species of the genus *Sataspes* (33) which occur in India have also been found only on plants of the same Order. Two of the three species of the genus *Haemorrhagia* (31) feed on *Caprifoliaceae* (lxxiv) and on the closely allied Order *Rubiaceae* (lxxv), and the third species may be expected to be found feeding on one of these two Orders. The two species of the genus *Cephonodes* (32) which is closely allied to *Haemorrhagia* (31), feed entirely on *Rubiaceae* (lxxv). The five genera *Cizara* (45), *Gurelca* (47), *Sphingonaeopiopsis* (48), *Rhodosoma* (50) and *Rhopalopsyche* (52), which, as may be seen from the numbers are closely allied, all feed only on *Rubiaceae* (lxxv), and thirteen species of the genus *Macroglossum* (51), closely allied to the above, also feed on plants of this Order, though other species of the genus feed on widely separated Orders. The two species of *Polyptychus* (16) feed only on *Boraginaceae* (c). The genera *Cypa* (24), *Smerinthulus* (25), and *Degmaptera* (26), all closely allied, feed only on *Cupuliferae* (cxl). The two species of *Leucophlebia* (15) are found only on *Gramineae* (clxxiii). In these cases a very close connection may be seen between closely allied species or genera of Hawk-moths and the plants on which their caterpillars feed, and a less close connection may be seen in the case of some other genera.

In the genus *Acherontia* (3) for instance, the two Indian species have common foodplants of the Orders *Leguminosae* (l), *Solanaceae* (cii) *Verbenaceae* (cxi) and *Labiatae* (cxii), but each of the species has foodplants of other Orders which are not common to both. Some of the caterpillars of each of the genera *Pergesa* (54), *Hippotion* (55), *Theretra* (56), *Rhagastis* (58) and *Cechenena* (59) feed on *Geraniaceae* (xxxii), *Ampelideae* (xliii) and *Aroideae* (clxvi) but they and other species of these genera feed also on plants of many other Orders, and the same applies to *Ampelophaga* (37), *Acosmeryx* (40), *Theretra* (56) and *Cechenena* (58), which feed on both *Ternstroemiaceae* (xxiv) and *Ampelideae* (xliii).

The cases where little or no connection is apparent are more numerous. There are three Indian species of the genus *Meganoton* (4). One species feeds on *Anonaceae* (iv), but we must jump to *Verbenaceae* (cxi) for the foodplants of the second species, and to *Laurineae* (cxxviii) for that of the third. There is thus a gap of one hundred and seven Orders of plants between the foodplants of the first two species, and of seventeen between the second and the third. There are fourteen Indian species of the genus *Theretra* (56), the foodplants of eleven of which are known. These eleven species feed on plants belonging to no less than nineteen Orders ranging from *Dilleniaceae* (ii) to *Aroideae* (clxvi), an immense range. The finding of a *Theretra* caterpillar on a plant of one of these Orders would not help one much in searching for those of others of the genus, or of those of allied genera.

There are two Indian species of the genus *Rhodoprasina* (20).

One of these feeds on *Sapindaceae* (xliv) while the other feeds on *Cupuliferae* (cxl), a hundred Orders intervening. It must be remembered that each Order of plants has a large number of species, and that the number of species of plants separating the two food-plants would run into thousands. The genera *Oxyambulyx* (13) and *Marumba* (17), with the foodplants of seven of their species known in each case, range over ten Orders of plants each. *Acherontai* (3) and *Hippotion* (55), the former with two and the latter with five Indian species, also range over ten Orders, widely separated in the botanical scale, in each case. Many more instances of a similar nature might be quoted, but enough have been given to show that closely allied species and genera frequently feed on widely separated Orders of plants.

There are also many examples of widely separated genera of Hawkmoths selecting plants of the same Order or even of the same species, for their food. Two *Marumba* (17) and a *Theretra* (55) select plants of the Order *Malvaceae* (xxvi) for their food. The Order *Tiliaceae* (xxvii) provides food for an *Oxyambulyx* (13), two *Marumba* (17), an *Agnosia* (22), a *Macroglossum* (51) and a *Theretra* (55). The Order *Rosaceae* (li) is selected by a *Marumba* (17), a *Langia* (19), a *Macroglossum* (51) and a *Celerio* (53). An *Acherontia* (3) and two *Theretra* (55) feed on plants of the Order *Myrtaceae* (lix). One plant of the Order *Pedaliaceae* (cvii) provides food for one *Acherontia* (3) and one *Hippotion* (50). It is clear that except for a dozen genera it would not be safe to predict the foodplant of any Indian Hawkmoth from a knowledge of those of allied genera or species.

Mention has been made above of five genera of Hawkmoths sharing three Orders of plants for their food, and this raises the interesting question as to why certain Orders or species of plants are selected by the moths as foodplants for their caterpillars. What quality is there in the leaves of certain plants which make them alone suitable as food for the caterpillars of certain species? Further research is necessary before this question can be settled beyond any doubt. We can only collect information by breeding as many species as possible, and record it for the use of some genius who with microscope, chemical reagents and what not, may find the true solution. Some of the species of five genera feed on *Geraniaceae* (xxxii), *Ampelideae* (xliii) and *Aroideae* (clxvi), and another genus selects *Ampelideae* and *Aroideae* for its food. What is the connecting link between *Geraniaceae* (balsams), *Ampelideae* (vines) and *Aroideae* (arums) which causes the moths of five or six genera to pick them out and their caterpillars to feed on them, starving in the midst of plenty if given the leaves of the plants of the numerous Orders in between? The moths do not feed on the flowers of the selected plants. They suck the honey from the flowers of the petunia, plumbago, phlox and other plants which do not form the food of any Hawkmoth caterpillar, and many of them do not feed at all, so no connecting link can be found there. One might suspect that the botanist's arrangement of the Orders is wrong, and that the Hawkmoth is a better botanist than the professor, but even the layman can appreciate the differ-

ence between the balsam, the grape vine and the cockoo-pint. Again, if we doubt the botanist's classification, we should have to place the Orders *Sapindaceae* (xliv) and *Cupuliferae* (cxl) together, to account for the predilection of the two species of *Rhodossoma*, and make many equally impossible adjustments. Further, we should be at a loss to account for the fact that five widely separated genera select plants of the Order *Tiliaceae* (xxvii) for their food, and that the Order *Leguminosae* (l) provides for seven widely separated genera. The one species of *Herse* (1) feeds on *Leguminosae* (l), *Compositae* (lxxviii) and *Convolvulaceae* (ci). It is the only species of Hawkmoth which is known to feed on the Order *Compositae*. The one species of *Psilogramma* (5) feeds on four Orders of plants, ranging from *Sabiaceae* (xlv) to *Verbenaceae* (cxi). One of the two species of *Pseudodolbina* (8) has selected plants of the Order *Acanthaceae* (cix) for its food, and it is the only species known to feed on plants of this Order. The one species of *Dolbina* (11) feeds on *Oleaceae* (xcii), which it shares with *Acherontia* (3) and *Psilogramma* (5). The one species of *Compsogene* (12) feeds on *Guttiferae* (xxiii) and *Anacardiaceae* (xliv), sharing the latter foodplant with four *Oxyambulyx* (13). The one species of *Daphnusa* (18) feeds on *Sapindaceae* (xliv), which it shares with one *Marumba* (17), one *Macroglossum* (51) and one *Celerio* (53). Two species of *Deilephila* are confined to the Order *Apocynaceae* (xciv), which they share with *Nephete* (46); a second species feeds on *Rubiaceae* (lxxv) and a third on *Cornaceae* (lxxii). Most of the species of *Rhagastis* (58) feeds on *Ampelideae* (xliii) and *Aroideae* (clxvi), but one species breaks away from the rest and feeds on *Saxifragaceae* (lii).

In the numerous examples given above there is evidence here and there of some method in the selection of foodplants by the moths, and but for this evidence we should be driven to believe that the selection had been made entirely haphazard. Some further evidence of method in selection is however afforded by the preference shown for certain Orders. No less than thirty-four species belonging to thirteen genera feed on plants of the Order *Rubiaceae* (lxxv), twenty-six belonging to eleven genera on *Ampelideae* (xliii), fifteen species on *AROIDEAE* (clxvi) and thirteen species on *Leguminosae* (l). On the other hand there are no less than nineteen Orders on which only one species feeds.

Up to now only Orders of plants have been mentioned. It does not follow that if a caterpillar will feed on one species of an Order that the other species will be equally acceptable. This is, in fact, very far from being the case. Only a few species of each Order are selected as foodplants. The Order *Leguminosae* is a very large one, with over eight hundred Indian species, but only twenty-one of these form the foodplant of any Hawkmoth, many common species being refused by caterpillars which feed on other plants of the Order. Only thirty-five species of the Order *Rubiaceae*, with over six hundred Indian species are accepted. Of the large Order *Compositae*, with hundreds of Indian species, only two are known to form the foodplant of any Hawkmoth. There are sixteen Orders of plants, all with many species, of which only

one species is accepted in each case. An examination of the species selected within each Order reveals the same result as in the case of the Orders themselves. Sometimes closely related and sometimes widely separated species are chosen. Some of the species selected as foodplants seem very curious. In the Order *Loganiaceae* the leaves of the deadly strychnine-tree are eaten by four species of Hawkmoths. In the Order *Solanaceae* the poisonous *Datura* is eaten, as well as the potato, brinjal and tobacco. The spurge and arums, poisonous to mammals, are eaten by many species. The foetid smelling leaves of *Paederia foetida* are eaten by some species as readily as those of sweet smelling species by others.

From observations made in the field it appears that the selection of certain plants, haphazard or otherwise, having once been made, the moths keep most faithfully to their choice. An egg of some common and prolific species may occasionally be found on a blade of grass growing close to the leaves of the true foodplant, but generally the eggs are deposited with the utmost certainty on the proper leaves. Some of the daylight-flying species may be watched, first darting about, then hovering over a tangled mass of herbage and daintily manoeuvring for position to deposit an egg, while still hovering, on a leaf or twig of the chosen plant. We do not know how it picks out the leaves of its foodplant from all the surrounding leaves, but it seldom makes a mistake. This is another problem which further investigation may solve.

The distribution of Hawkmoths, and the number of individuals of any species occurring in any locality, is intimately connected with their choice of foodplants, and by the distribution of those foodplants. The moths themselves, being fast and powerful flyers, may be found at some distance beyond the range of their foodplants, but they can only maintain themselves and reproduce their kind in areas where at least one of their foodplants grows. The choice of their foodplants is thus a very important factor, affecting their very existence in any locality. The disappearance of a plant may cause the disappearance of a species of Hawkmoth, and the spreading of a plant, by natural or artificial means, may cause another species to extend its range. Certain species feed on plants which are grown as crops, and occur in great numbers wherever it is cultivated. One species feeds on apple and pear, and finds its way to newly started orchards, thus extending its range. There is some evidence to show that vigorous species are willing to adopt a new foodplant, and this may lead to an extension of their range or to a local increase in numbers. One species of *Rhagastis* feeds on the hydrangea in Shillong. It must have adopted the hydrangea as its food after this plant had been artificially introduced into the gardens there. It is a hardy species, and neither its egg nor its larva appears to be attacked by any parasites, and it has thriven and multiplied exceedingly. Thousands of its caterpillars are destroyed every year by indignant *malis*; many more are killed by ants when they are on the ground looking for fresh bushes to attack or when about to pupate; but it swarms in apparently undiminished numbers each season. The moth has become one of

the most common of the Hawkmoths locally, but away from the station of Shillong it is rarely found. Rudolph Mell has found the same species feeding on a closely allied plant in South China. The walnut, Order *Juglandeae*, is another plant which has been artificially introduced into Shillong, and a species of *Oxyambulyx*, which feeds on a tree of the closely allied Order *Myricaceae*, has adopted the walnut also as one of its foodplants. The lantana has been introduced into India comparatively recently, and one of the *Acherontia*, which feeds on other plants of the same Order, has adopted it also, and other similar cases might be quoted.

The range of any species of Hawkmoth is by no means coincident with that of its foodplant or plants. While some of the common species may be found wherever any of their foodplants are available to support their caterpillars, other species have a range which is far more restricted than that of their foodplants. The wild vine and the wild arum are found at suitable elevations throughout the Khasi Hills and the Himalayas, but some of the species which feed on these plants are confined to the Khasi Hills and the Eastern Himalayas, others to the Western Himalayas; some to the Khasi Hills alone. Some species are found only in very restricted areas, though their foodplants cover a wide range. One species of a genus may be common and widespread, another, closely allied and feeding on the same plant, rare and restricted.

It will be seen that there are many problems regarding the choice of foodplants by Hawkmoths, and with regard to their distribution, which require further investigation.